

Dietary effects of *Microcystis aeruginosa* on threadfin shad, *Dorosoma petenense*

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Outline

- *Microcystis aeruginosa*
- Threat to ecosystems
- Dietary effects
- Future directions



Microcystis aeruginosa

- Harmful algal blooms
- Temperate and tropical freshwater
- Eutrophic water
- Worldwide distribution
- Vertical migration



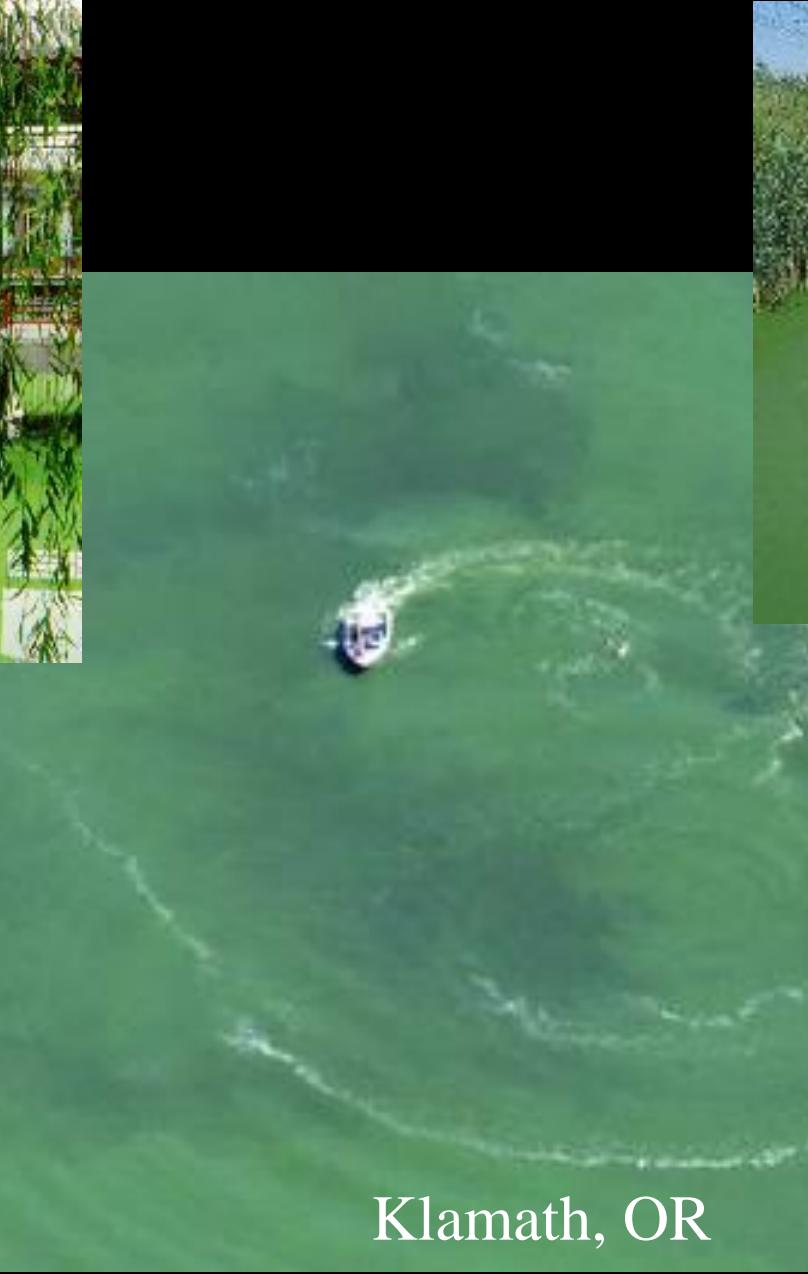
Ohio, USGS



China



Norway



Klamath, OR



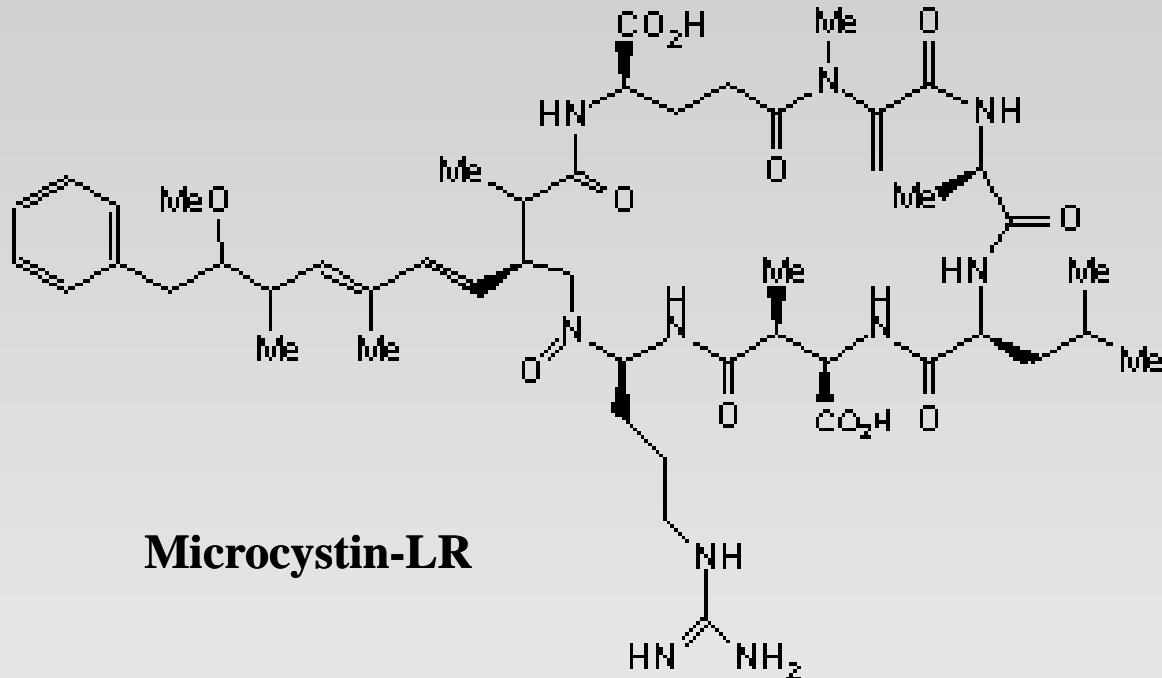
South Africa



Australia

Toxicity

- Microcystin
 - ◆ 80 congeners
 - ◆ Protein phosphatase inhibition
 - ◆ Liver lesions
 - ◆ Growth
 - ◆ Mortality

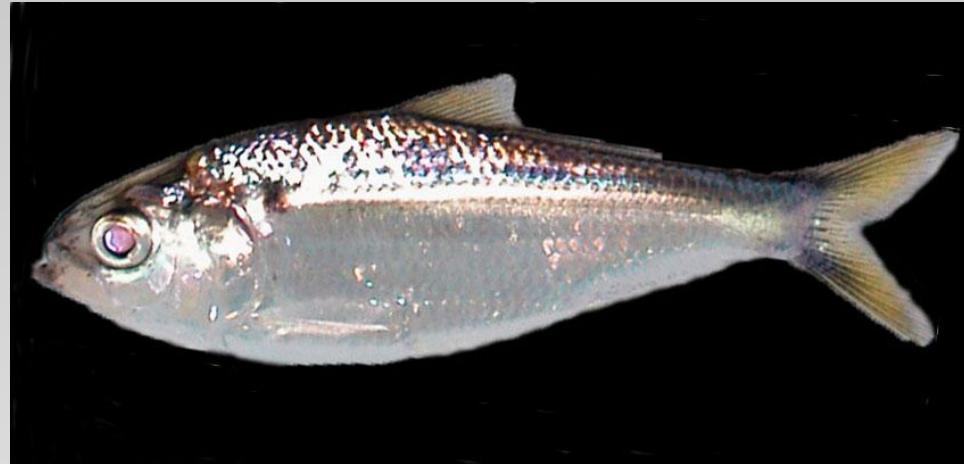


Threat to ecosystems

- Population shifts
 - ◆ Phytoplankton
 - ◆ Invertebrates
 - ◆ Fish
- San Francisco Estuary
 - ◆ Optimal conditions
 - ◆ LR form
 - ◆ Pelagic Organism Decline

Threadfin shad

- Pelagic Organism Decline
- Larval and juveniles
- Pelagic food web
- MC concentrations
 - ◆ Copepods
 - ◆ Bloom
 - ◆ Ambient



Threadfin shad dietary exposure

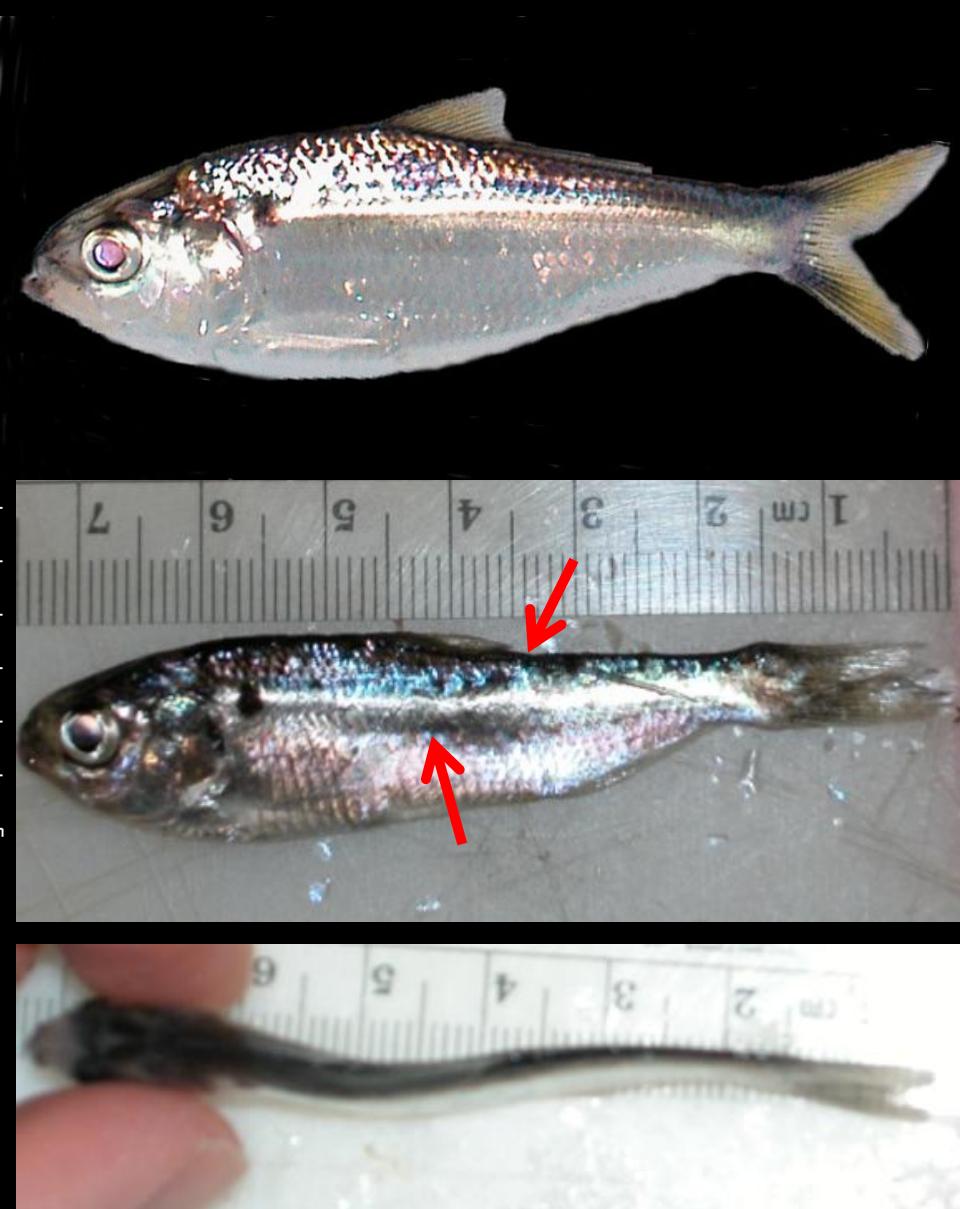
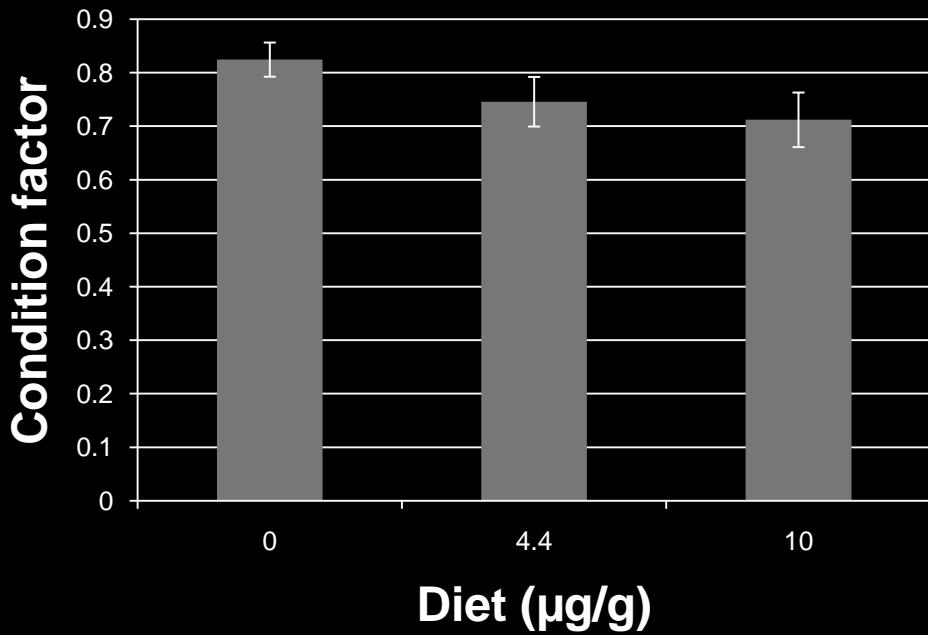
- 10 fish/rep, 3 reps
- 25 0.5°C
- 3 diets at 2% BW/d
- 2 months
- 3 Recirculating aquaculture system
- Fluidized sand filter
- Carbon filter



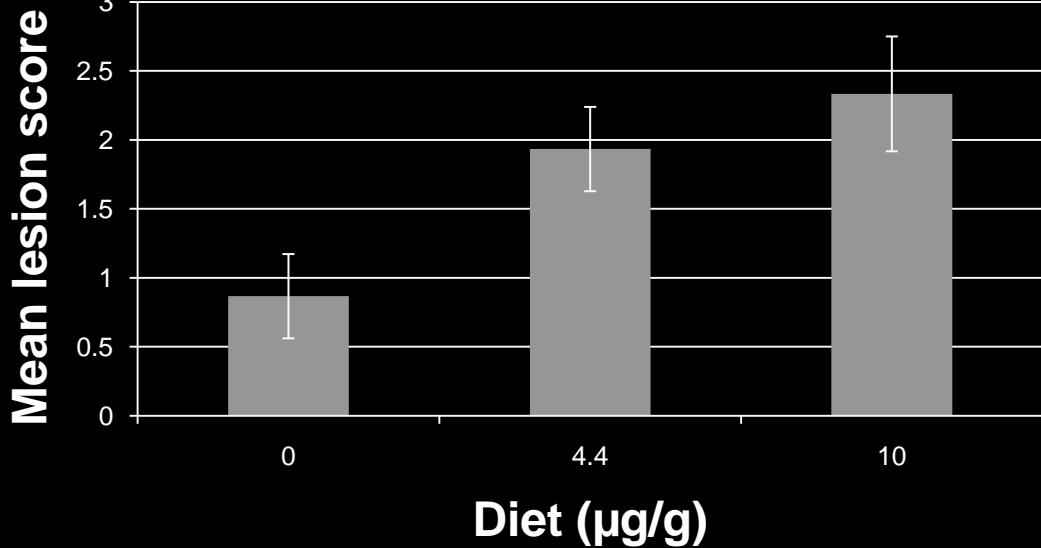
Diets

- 3 diets with μg of MC-LR /g dry wt.
 - ◆ 0 $\mu\text{g/g}$
 - ◆ 4.4 $\mu\text{g/g}$
 - ◆ 10 $\mu\text{g/g}$
- MC-LR source; *M. aeruginosa* from the SFE

Condition factor

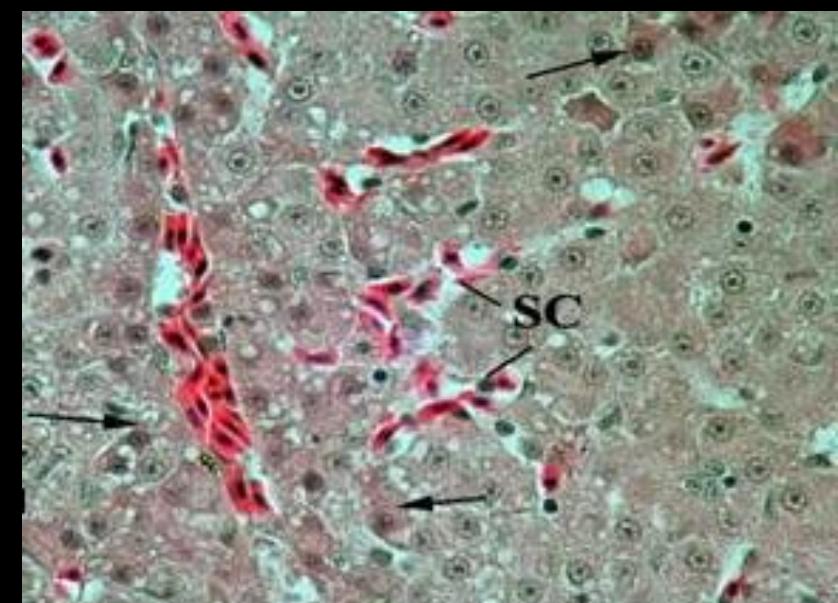
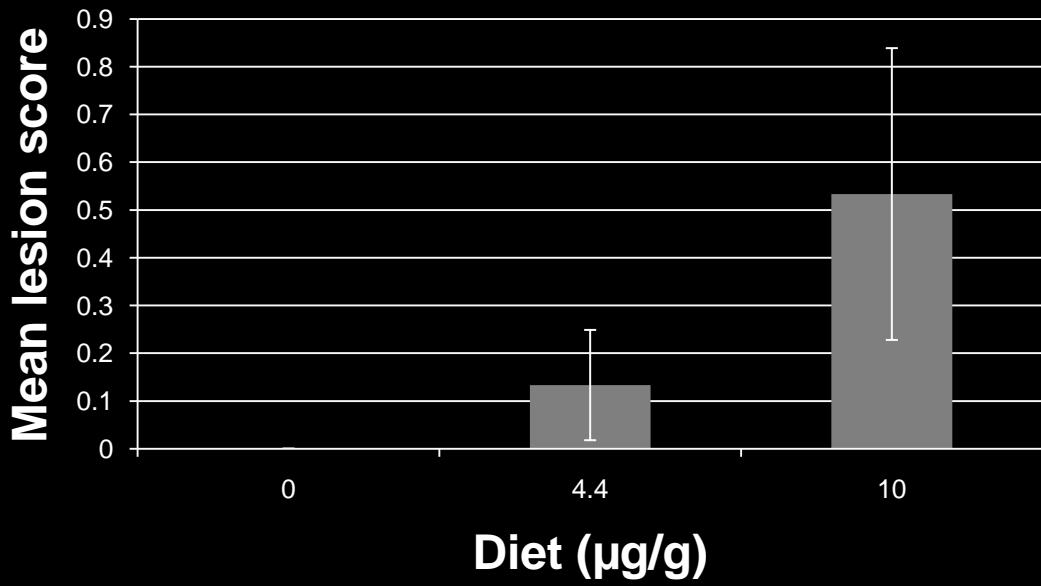


Glycogen depletion



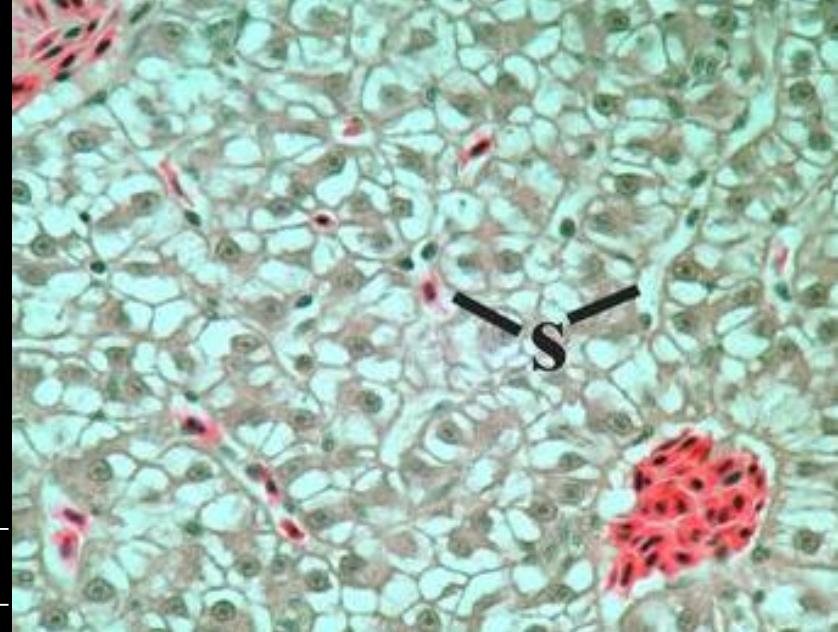
0 $\mu\text{g/g}$

Sinusoidal congestion

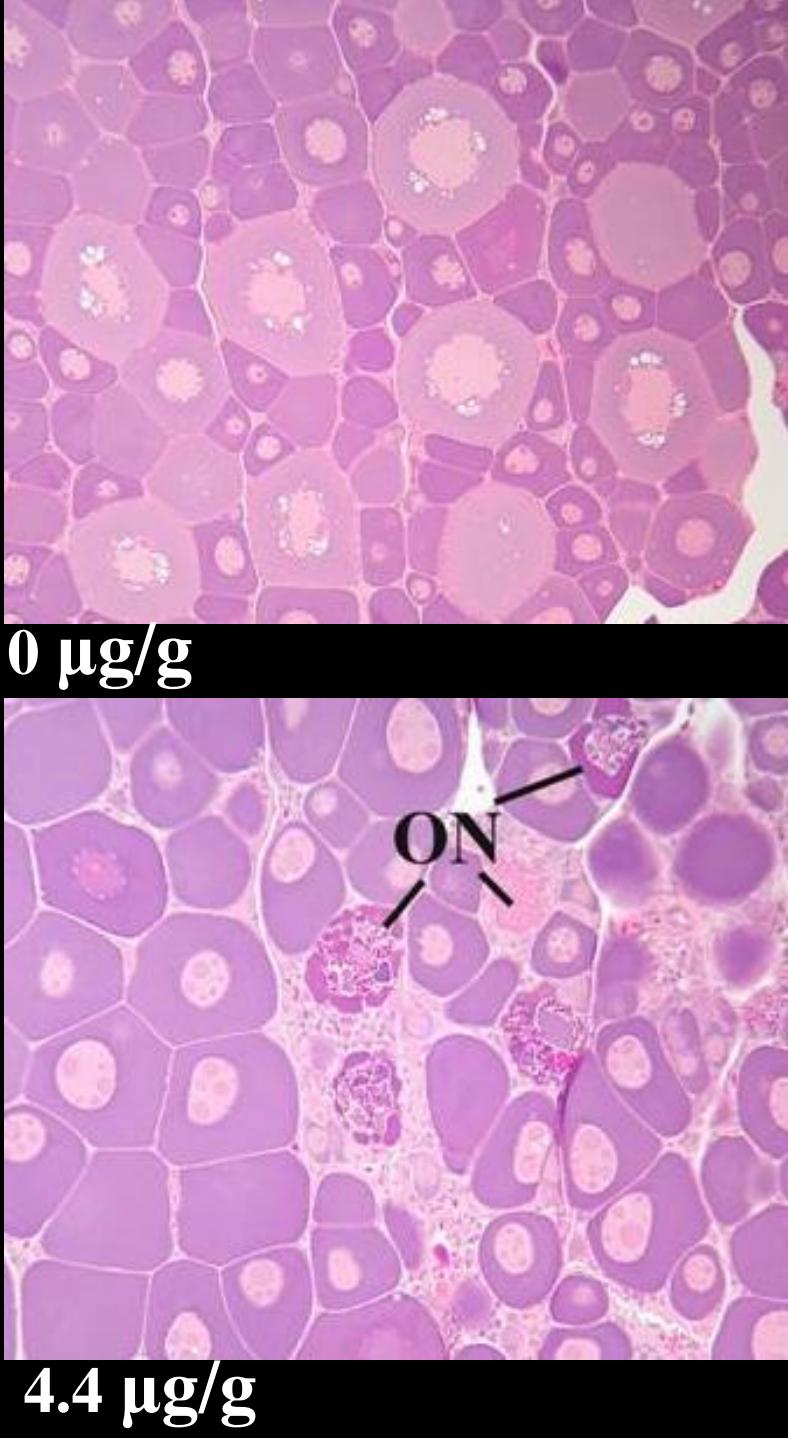
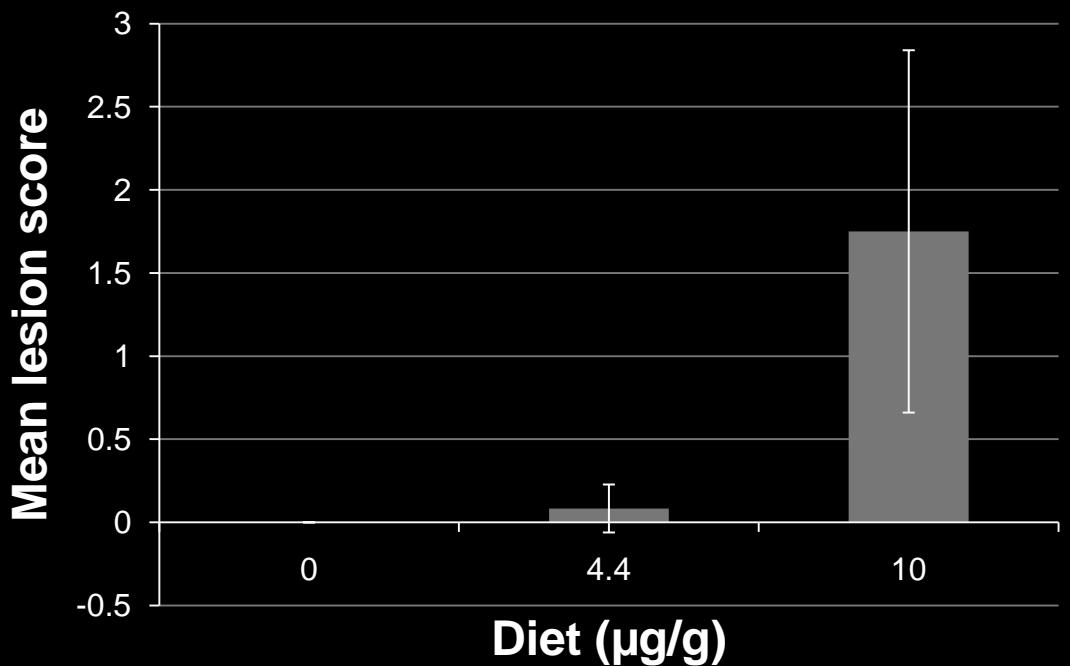


4.4 $\mu\text{g/g}$

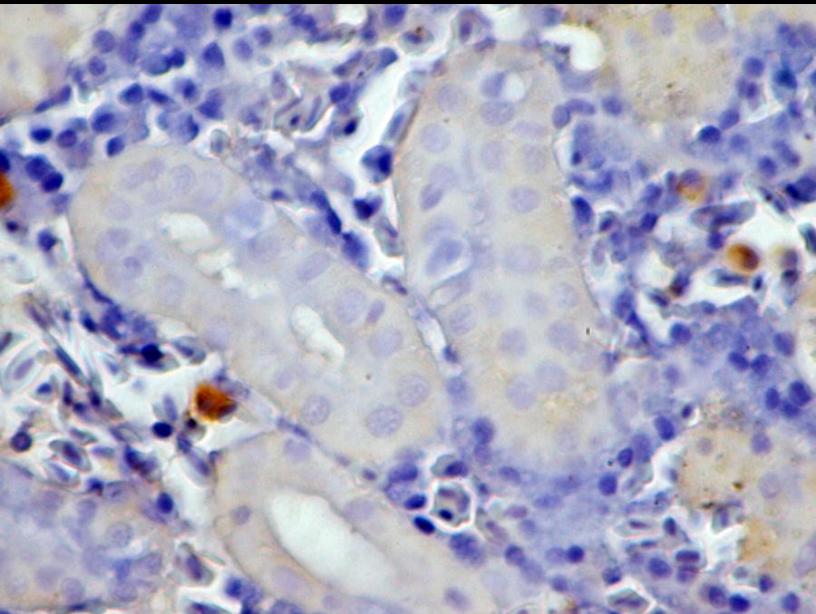
Eosinophilic protein droplets



Ovarian atresia



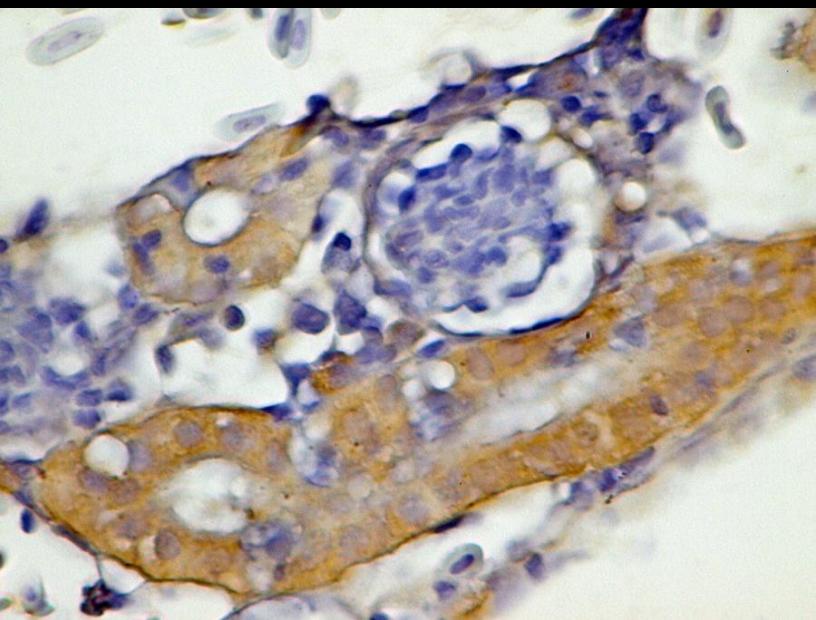
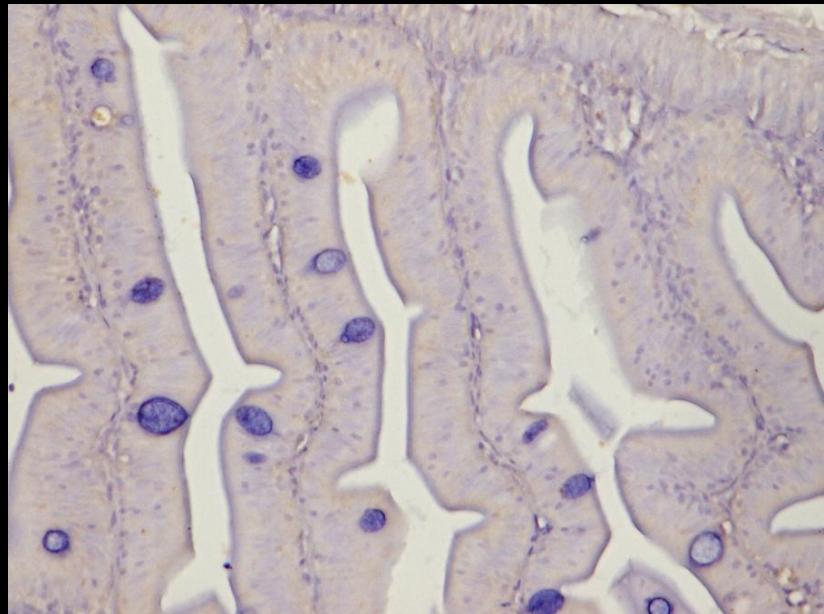
Kidney



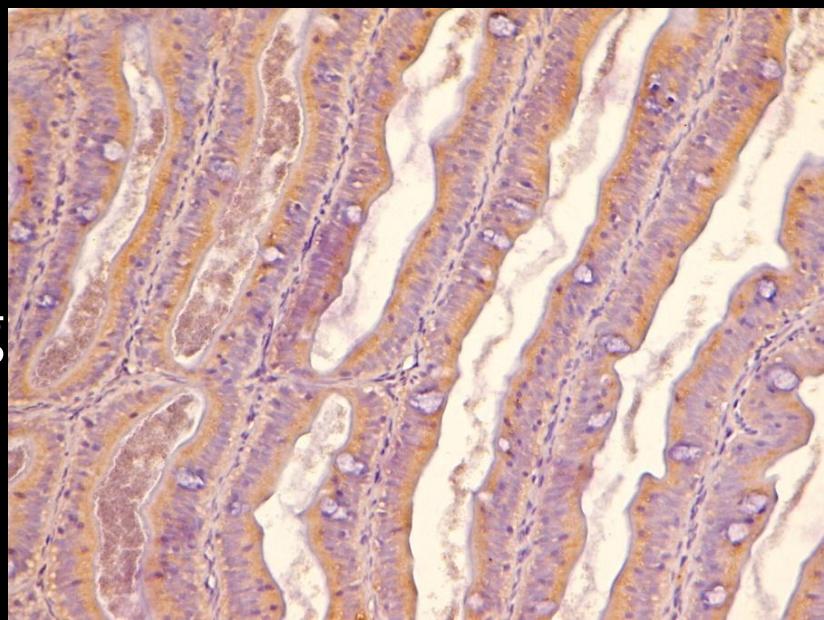
MC-LR

0 $\mu\text{g/g}$

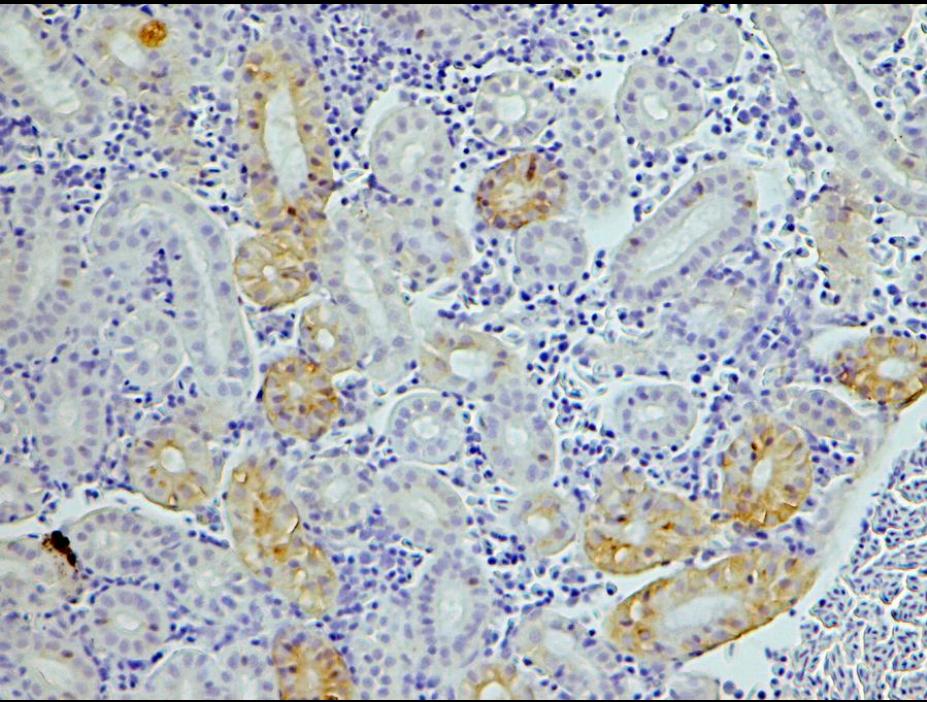
Intestine



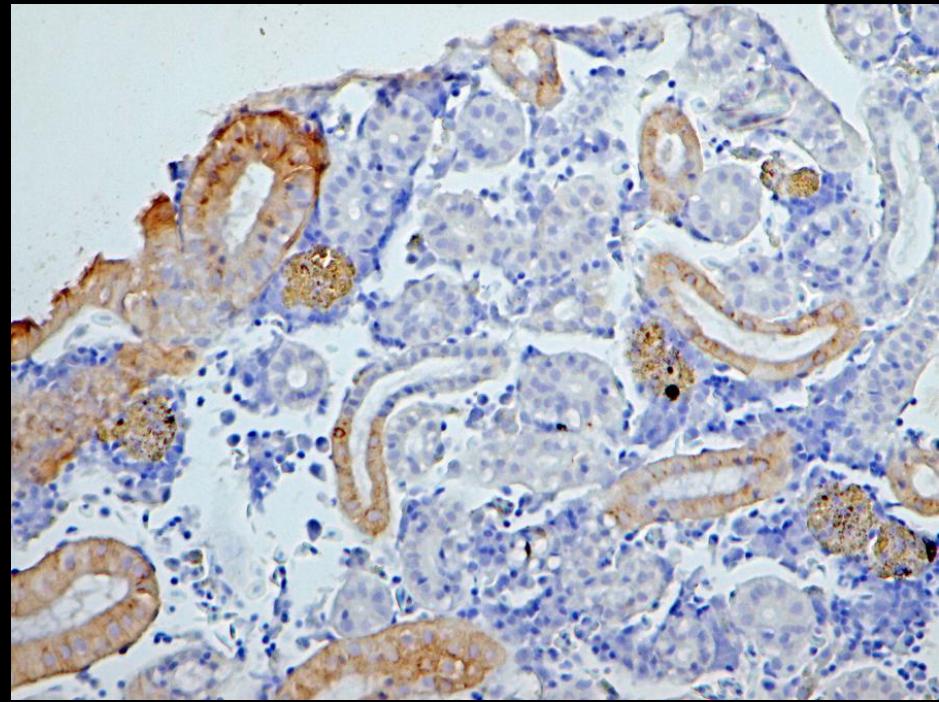
4.4 $\mu\text{g/g}$



CYP1A in the kidney



0 $\mu\text{g/g}$



4.4 $\mu\text{g/g}$

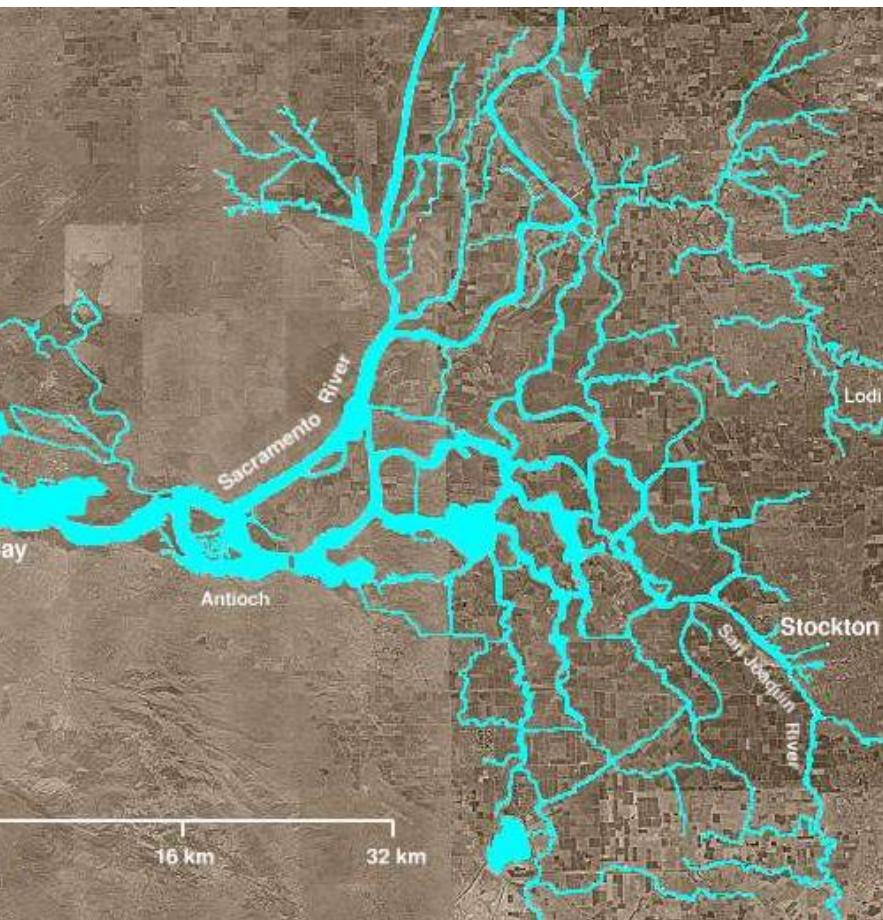
Concentration of MC-LR ($\mu\text{g/g}$) with increased response

Biomarker	[†] Medaka (2 months)	[‡] Splittail (1 month)	Threadfin shad (2 months)
Condition Factor	0.46	NE	4.40
RNA/DNA	2.01	3.55	pending
Protein Phosphatase 2A	0.85	NE	pending
Liver lesions	3.96	3.55	4.40
Reproduction	3.96	N/A	4.40

[†]Deng, DF, Zheng, K, Teh, FC, Lehman, PW, Teh, SJ. 2009. Toxic threshold of dietary microcystin (-LR) for quart medaka. *Toxicon*. **55**(4). 1-8.

[‡] Acuña, SC, Deng, DF, Lehman, PW, Teh, SJ. Dietary effects of *Microcystis* on Sacramento splittail, *Pogonichthys macrolepidotus*. *Unpublished*.

Future direction



- Additional analyses
 - Immunohistochemistry
 - Enzyme histochemistry
 - *In situ* hybridization
- Field sampling
 - Time and place
 - *In situ* biomarkers
 - Detecting microcystin
- Alternative species

Acknowledgments

- Funded by Department of Water Resources Contract No. #4600008137 and Aquatic Toxicology Program Research Grant
- Dr. Ted Sommers, DWR
- Ching Teh for the histopathological work and support
- Dr. Birgit Puschner (UCD) for microcystin analysis
- Jessie Hofius, Thien Nguyen, Michelle Kawaguchi

Questions?

